Listing of the Claims

This listing of claims will replace all prior versions and listings of the claims in the application.

1. (original) Steel plate for ultra-high-strength linepipe having excellent low-temperature toughness consisting of:

C	: 0.03 to 0.07 mass%
Si	: not more than 0.6 mass%
Mn	: 1.5 to 2.5 mass%
P	: not more than 0.015 mass%
S	: not more than 0.003 mass%
Mo	: 0.15 to 0.60 mass%
Nb	: 0.01 to 0.10 mass%
Ti	: 0.005 to 0.030 mass%
Al	: not more than 0.10 mass%

and, one or more of:

Ni	: 0.1 to 1.5 mass%
B	: less than 3 ppm
V	: not more than 0.10 mass%
Cu	: not more than 1.0 mass%
Cr	: not more than 1.0 mass%
Ca	: not more than 0.01 mass%
REM	: not more than 0.02 mass%
Mg	: not more than 0.006 mass%

and the remainder consisting of iron and unavoidable impurities and having the value P defined below being between 2.5 and 4.0, in which;

the ratio (Hv-avep)/(Hv-M) between the average Vickers hardness Hv-avep in the direction of thickness and the martensitic hardness Hv-M determined by carbon content is between 0.8 and 0.9, and the transverse tensile strength TS-Tp is between 880 MPa and 1080 MPa,

$$P = 2.7C + 0.4Si + Mn + 0.8Cr + 0.45(Ni + Cu) + Mo - 1$$

$$Hv\text{-}M = 270 + 1300C$$

wherein the symbols of elements designate the mass% of the individual elements.

2. (original) Steel plate for ultra-high-strength linepipe having excellent low-temperature toughness consisting of:

C	: 0.03 to 0.07 mass%
Si	: not more than 0.6 mass%
Mn	: 1.5 to 2.5 mass%
P	: not more than 0.015 mass%
S	: not more than 0.003 mass%
Mo	: 0.15 to 0.60 mass%
Nb	: 0.01 to 0.10 mass%
Ti	: 0.005 to 0.030 mass%
Al	: not more than 0.10 mass%
B	: 3 ppm to 0.0025 mass%

and, one or more of:

Ni	: 0.1 to 1.5 mass%
N	: 0.001 to 0.006 mass%
V	: not more than 0.10 mass%
Cu	: not more than 1.0 mass%
Cr	: not more than 1.0 mass%

Ca : not more than 0.01 mass%

REM : not more than 0.02 mass%

Mg : not more than 0.006 mass%

and the remainder consisting of iron and unavoidable impurities and having the value P defined below being between 2.5 and 4.0, in which;

the ratio (Hv-avep)/(Hv-M) between the average Vickers hardness Hv-avep in the direction of thickness and the martensitic hardness Hv-M determined by carbon content is between 0.8 and 0.9, and the transverse tensile strength TS-Tp is between 880 MPa and 1080 MPa,

$$P = 2.7C + 0.4Si + Mn + 0.8Cr + 0.45(Ni + Cu) + 2Mo$$

$$Hv\text{-}M = 270 + 1300C$$

wherein the symbols of elements designate the mass% of the individual elements.

3. (currently amended) Steel plate for ultra-high-strength linepipe having excellent low-temperature toughness described in ~~claim 1 or 2~~ claim 1, containing:

N : 0.001 to 0.006 mass%.

4. (original) Steel plate for ultra-high-strength linepipe having excellent low-temperature toughness described in claim 3, in which the relationship $Ti - 3.4\,N > 0$ is satisfied (wherein the symbols of elements designate the mass% of the individual elements).

5. (currently amended) Steel plate for ultra-high-strength linepipe having excellent low-temperature toughness described in ~~any of claims 1 to 4~~ claim 1, in which the V-notch Charpy value at -20 °C is not lower than 200J.

6. (currently amended) Steel plate for ultra-high-strength linepipe having excellent low-temperature toughness described in ~~any of claims 1 to 5~~ claim 1, in which the longitudinal tensile strength TS-Lp is not greater than 0.95 times the transverse tensile strength TS-Tp.

7. (currently amended) Steel plate for ultra-high-strength linepipe having excellent low-temperature toughness described in ~~any of claims 1 to 6~~ claim 1, in which the yield ratio in the direction of rolling (YS - Lp)/(TS - Lp), which is the ratio of the 0.2% offset yield strength YS - Lp in the direction of rolling to the tensile strength TS - Lp in the direction of rolling is not greater than 0.8.

8. (original) Ultra-high-strength linepipe having excellent low-temperature toughness prepared by seam-welding steel plate consisting of:

C : 0.03 to 0.07 mass%

Si : not more than 0.6 mass%

Mn : 1.5 to 2.5 mass%

P : not more than 0.015 mass%

S : not more than 0.003 mass%

Ni : 0.1 to 1.5 mass%

Mo : 0.15 to 0.60 mass%

Nb : 0.01 to 0.10 mass%

Ti : 0.005 to 0.030 mass%

Al : not more than 0.06 mass%

and, one or more of:

B : not more than 0.0025 mass%

N : 0.001 to 0.006 mass%

V : not more than 0.10 mass%

Cu : not more than 1.0 mass%

Cr : not more than 1.0 mass%

Ca : not more than 0.01 mass%

REM : not more than 0.02 mass%

Mg : not more than 0.006 mass%

and the remainder consisting of iron and unavoidable impurities and having the value P defined below being between 2.5 and 4.0, in which;

the ratio (Hv-ave)/(Hv-M) between the average Vickers hardness Hv-ave in the direction of thickness of the base metal and the martensitic hardness Hv-M determined by carbon content is between 0.8 and 0.9 and the circumferential tensile strength TS-C is between 900 MPa and 1100 MPa,

$$P = 2.7C + 0.4Si + Mn + 0.8Cr + 0.45(Ni + Cu) + (1 + \beta)Mo - 1+\beta$$

where $\beta = 1$ when $B \geq 3$ ppm and $\beta = 0$ when $B < 3$ ppm

$$Hv\text{-}M = 270 + 1300C$$

wherein the symbols of elements designate the mass% of the individual elements.

9. (original) Ultra-high-strength linepipe having excellent low-temperature toughness prepared by seam-welding steel plate consisting of:

C : 0.03 to 0.07 mass%

Si : not more than 0.6 mass%

Mn : 1.5 to 2.5 mass%

P : not more than 0.015 mass%

S : not more than 0.003 mass%

Mo : 0.15 to 0.60 mass%

Nb : 0.01 to 0.10 mass%

Ti : 0.005 to 0.030 mass%

Al : not more than 0.10 mass%

and, one or more of:

Ni : 0.1 to 1.5 mass%

B : less than 3 ppm

V : not more than 0.10 mass%

Cu : not more than 1.0 mass%

Cr : not more than 1.0 mass%

Ca : not more than 0.01 mass%

REM : not more than 0.02 mass%

Mg : not more than 0.006 mass%

and the remainder consisting of iron and unavoidable impurities and having the value P defined below being between 2.5 and 4.0, in which;

the ratio (Hv-ave)/(Hv-M*) between the average Vickers hardness Hv-ave in the direction of thickness of the base metal and the martensitic hardness Hv-M* determined by carbon content is between 0.75 and 0.9 and the circumferential tensile strength TS-C is between 900 MPa and 1100 MPa,

$$P = 2.7C + 0.4Si + Mn + 0.8Cr + 0.45(Ni + Cu) + Mo - 1$$

$$Hv\text{-}M^* = 290 + 1300C$$

wherein the symbols of elements designate the mass% of the individual elements.

10. (original) Ultra-high-strength linepipe having excellent low-temperature toughness prepared by seam-welding steel plate consisting of:

C : 0.03 to 0.07 mass%

Si : not more than 0.6 mass%

Mn : 1.5 to 2.5 mass%

P : not more than 0.015 mass%

S : not more than 0.003 mass%

Mo : 0.15 to 0.60 mass%

Nb : 0.01 to 0.10 mass%

Ti : 0.005 to 0.030 mass%

Al : not more than 0.10 mass%

B : 3 ppm to 0.0025 mass%

and, one or more of:

Ni : 0.1 to 1.5 mass%

N : 0.001 to 0.006 mass%

V : not more than 0.10 mass%

Cu : not more than 1.0 mass%

Cr : not more than 1.0 mass%

Ca : not more than 0.01 mass%

REM : not more than 0.02 mass%

Mg : not more than 0.006 mass%

and the remainder consisting of iron and unavoidable impurities and having the value P defined below being between 2.5 and 4.0, in which;

the ratio (Hv-ave)/(Hv-M*) between the average Vickers hardness Hv-ave in the direction of thickness of the base metal and the martensitic hardness Hv-M* determined by carbon content is between 0.75 and 0.9 and the circumferential tensile strength TS-C is between 900 MPa and 1100 MPa,

$$P = 2.7C + 0.4Si + Mn + 0.8Cr + 0.45(Ni + Cu) + 2Mo$$

Hv-M* = 290 + 1300C

wherein the symbols of elements designate the mass% of the individual elements.

11. (currently amended) Ultra-high-strength linepipe having excellent low-temperature toughness described in ~~claim 9 or 10~~ claim 9 containing:

N : 0.001 to 0.006 mass%.

12. (original) Ultra-high-strength linepipe having excellent low-temperature toughness described in claim 11, in which the relationship Ti - 3.4 N > 0 is satisfied (wherein the symbols of elements designate the mass% of the individual elements).

13. (currently amended) Ultra-high-strength linepipe having excellent low-temperature toughness described in ~~any of claims 8 to 12~~ claim 8, in which the V-notch Charpy value at -20 °C is not lower than 200J.

14. (currently amended) Ultra-high-strength linepipe having excellent low-temperature toughness described in ~~any of claims 8 to 13~~ claim 8, in which the tensile strength in the longitudinal direction of linepipe is not greater than 0.95 times the tensile strength in the circumferential direction thereof.

15. (original) A method for manufacturing steel plate for ultra-high-strength linepipe having excellent low-temperature toughness comprising the steps of:

heating slabs consisting of:

C : 0.03 to 0.07 mass%

Si : not more than 0.6 mass%

Mn : 1.5 to 2.5 mass%

P : not more than 0.015 mass%

S : not more than 0.003 mass%

Mo : 0.15 to 0.60 mass%

Nb : 0.01 to 0.10 mass%

Ti : 0.005 to 0.030 mass%

Al : not more than 0.10 mass%

and, one or more of:

Ni : 0.1 to 1.5 mass%

B : less than 3 ppm

V : not more than 0.10 mass%

Cu : not more than 1.0 mass%

Cr : not more than 1.0 mass%

Ca : not more than 0.01 mass%

REM : not more than 0.02 mass%

Mg : not more than 0.006 mass%

and the remainder consisting of iron and unavoidable impurities and having the value P defined below being between 2.5 and 4.0 and between 1000 and 1250 °C,

rough rolling in a recrystallizing region,

rolling in an unrecrystallization austenitic region at 900 °C or below with a cumulative rolling reduction of not less than 75% and, then,

applying accelerated cooling from the austenitic region so that the center of plate thickness cools to 500 °C or below at a rate of 1 to 10 °C/sec.,

$$P = 2.7C + 0.4Si + Mn + 0.8Cr + 0.45(Ni + Cu) + Mo - 1$$

wherein the symbols of elements designate the mass% of the individual elements.

16. (original) A method for manufacturing steel plate for ultra-high-strength linepipe having excellent low-temperature toughness comprising the steps of:

heating slabs consisting of:

C	: 0.03 to 0.07 mass%
Si	: not more than 0.6 mass%
Mn	: 1.5 to 2.5 mass%
P	: not more than 0.015 mass%
S	: not more than 0.003 mass%
Mo	: 0.15 to 0.60 mass%
Nb	: 0.01 to 0.10 mass%
Ti	: 0.005 to 0.030 mass%
Al	: not more than 0.10 mass%
B	: 3 ppm to 0.0025 mass%

and, one or more of:

Ni	: 0.1 to 1.5 mass%
N	: 0.001 to 0.006 mass%
V	: not more than 0.10 mass%
Cu	: not more than 1.0 mass%
Cr	: not more than 1.0 mass%
Ca	: not more than 0.01 mass%
REM	: not more than 0.02 mass%
Mg	: not more than 0.006 mass%

and the remainder consisting of iron and unavoidable impurities and having the value P defined below being between 2.5 and 4.0 and between 1000 and 1250 °C,

rough rolling in a recrystallized region,

rolling in an unrecrystallization austenitic region at 900 °C or below with a cumulative rolling reduction of not less than 75% and, then,

applying accelerated cooling from the austenitic region so that the center of plate thickness cools to 500 °C or below at a rate of 1 to 10 °C/sec.,

$$P = 2.7C + 0.4Si + Mn + 0.8Cr + 0.45(Ni + Cu) + 2Mo$$

wherein the symbols of elements designate the mass% of the individual elements.

17. (currently amended) A method for manufacturing steel plate for ultra-high-strength linepipe having excellent low-temperature toughness described in ~~claim 15 or 16~~ claim 15, in which slabs also contain

N : 0.001 to 0.006 mass%.

18. (original) A method for manufacturing steel plate for ultra-high-strength linepipe having excellent low-temperature toughness described in 17, in which the relationship $Ti - 3.4\,N > 0$ is satisfied (wherein the symbols of elements designate the mass% of the individual elements).

19. (currently amended) A method for manufacturing ultra-high-strength linepipe having excellent low-temperature toughness comprising the steps of:

forming a steel plate manufactured by the methods for manufacturing ultra-high-strength steel plate having excellent low-temperature toughness described in ~~any of claims 15 to 18~~ claim 15 into a pipe form so that the rolling direction of the steel plate agrees with the longitudinal direction of a pipe to be manufactured, and

forming a pipe by seam-welding together the edges thereof.

20. (currently amended) A method for manufacturing ultra-high-strength linepipe having excellent low-temperature toughness comprising the steps of:

forming a steel plate manufactured by the methods for manufacturing ultra-high-strength steel plate having excellent low-temperature toughness described in ~~any of claims 15 to 18~~ claim 15 into a pipe form by the UO process so that the rolling direction of the steel plate agrees with the longitudinal direction of a pipe to be manufactured,

forming a pipe by joining together the edges thereof by applying submerged-arc welding from both inside and outside, and

expanding the welded pipe.

21. (original) A method for manufacturing ultra-high-strength linepipe having excellent low-temperature toughness comprising the steps of:

heating slabs consisting of:

C	: 0.03 to 0.07 mass%
Si	: not more than 0.6 mass%
Mn	: 1.5 to 2.5 mass%
P	: not more than 0.015 mass%
S	: not more than 0.003 mass%
Ni	: 0.1 to 1.5 mass%
Mo	: 0.15 to 0.60 mass%
Nb	: 0.01 to 0.10 mass%
Ti	: 0.005 to 0.030 mass%
Al	: not more than 0.06 mass%

and, one or more of:

B	: not more than 0.0025 mass%
N	: 0.001 to 0.006 mass%

V : not more than 0.10 mass%

Cu : not more than 1.0 mass%

Cr : not more than 1.0 mass%

Ca : not more than 0.01 mass%

REM : not more than 0.02 mass%

Mg : not more than 0.006 mass%

and the remainder consisting of iron and unavoidable impurities and having the value P defined below being between 2.5 and 4.0 and between 1000 and 1250 °C,

rough rolling in a recrystallized region,

rolling in an unrecrystallization austenitic region at 900 °C or below with a cumulative rolling reduction of not less than 75%,

applying accelerated cooling from the austenitic region so that the center of plate thickness cools to 500 °C or below at a rate of 1 to 10 °C/sec.,

forming the steel plate thus manufactured into a pipe form so that the rolling direction of the steel plate agrees with the longitudinal direction of a pipe to be manufactured, and

forming a pipe by welding together the edges thereof.

$$P = 2.7C + 0.4Si + Mn + 0.8Cr + 0.45(Ni + Cu) + (1 + \beta)Mo - 1+\beta$$

where $\beta = 1$ when $B \geq 3$ ppm and $\beta = 0$ when $B < 3$ ppm

wherein the symbols of elements designate the mass% of the individual elements.

22. (original) A method for manufacturing ultra-high-strength linepipe having excellent low-temperature toughness described in claim 21, which furthermore comprising the steps of:

forming the steel plate subjected to accelerated cooling into a pipe form by the UO process so that the rolling direction of the steel plate agrees with the longitudinal direction of a pipe to be manufactured,

joining the edges thereof together by applying submerged-arc welding from both inside and outside, and

expanding the welded pipe.